Empirical Research in Software Architecture - How far have we come? Supplementary Material

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Report CW 691, February 2016

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Abstract

Empirical research helps gain well-founded insights about phenomena. Furthermore, empirical research creates evidence for the validity of research results. Objective: We aim at assessing the state-of-practice of empirical research in software architecture. Method: We conducted a comprehensive survey based on the systematic mapping method. We included all full technical research papers published at major software architecture conferences between 1999 and 2015. Results: 17% of papers report empirical work. The number of empirical studies in software architecture has started to increase in 2005. Looking at the number of papers, empirical studies are about equally frequently used to a) evaluate newly proposed approaches and b) to explore and describe phenomena to better understand software architecture practice. Case studies and experiments are the most frequently used empirical methods. Almost half of empirical studies involve human participants. The majority of these studies involve professionals rather than students. Conclusions: Our findings are meant to stimulate researchers in the community to think about their expectations and standards of empirical research. Our results indicate that software architecture has become a more mature domain with regards to applying empirical research. However, we also found issues in research practices that could be improved (e.g., when describing study objectives and acknowledging limitations). This report contains the supplementary material of the paper "Empirical Research in Software Architecture - How far have we come?", presented at the 13th Working IEEE/IFIP Conference on Software Architecture, Venice, Italy, 2016.

Keywords : software architecture, empirical research, state-of-practice.

Supplementary material and raw data for M. Galster, D. Weyns, "Empirical Research in Software Architecture - How far have we come?", 13th Working IEEE/IFIP Conference on Software Architecture, Venice, Italy, 2016

Primary studies

ID	Venue	Year	Paper
1	WICSA	2015	A Study on Architectural Decision Making in Context
2	WICSA	2015	An Architectural Framework for Collective Intelligence Systems
3	WICSA	2015	Architectural Technical Debt Identification based on Architecture Decisions and Change Scenarios
4	WICSA	2015	Enriching Architecture Knowledge with Technology Design Decisions
5	WICSA	2015	Hotspot Patterns: The Formal Definition and Automatic Detection of Architecture Smells
6	WICSA	2015	Proactive Detection of Higher-Order Software Design Conflicts
7	WICSA	2015	The Danger of Architectural Technical Debt: Contagious Debt and Vicious Circles
8	WICSA	2014	A Study on Group Decision-Making in Software Architecture
9	WICSA	2014	Architectural Decisions for HW/SW Partitioning Based on Multiple Extra-Functional Properties
10	WICSA	2014	Deriving Component Interfaces after a Restructuring of a Legacy System
11	WICSA	2014	Industrial Implementation of a Documentation Framework for Architectural Decisions
12	WICSA	2014	Scapegoat- An Adaptive Monitoring Framework for Component-Based Systems
13	WICSA	2014	The Role of Platform Boundary Resources in Software Ecosystems - A Case Study
14	WICSA	2014	The Supportive Effect of Traceability Links in Architecture-Level Software Understanding - Two Controlled Experiments
15	WICSA	2014	Towards an Evidence-Based Understanding of Emergence of Architecture through Continuous Refactoring in Agile Software Development
16	WICSA	2011	An Architectural Approach to Support Online Updates of Software Product Lines
17	WICSA	2011	Handling Variability in Software Architecture- Problems and Implications
18	WICSA	2011	Mature Architecting - A Survey about the Reasoning Process of Professional Architects
19	WICSA	2011	Prioritizing Architectural Concerns
20	WICSA	2011	Quantifying the Analyzability of Software Architectures
21	WICSA	2011	The Boomeranged Software Architect
22	WICSA	2008	A Just-In-Time Architectural Knowledge Sharing Portal
23	WICSA	2008	Analysis of Architecture Pattern Usage in Legacy System Architecture Documentation
24	WICSA	2008	Analyzing the Evolution of Large-Scale Software Systems Using Design Structure Matrices and Design Rule Theory- Two Exploratory Cases
25	WICSA	2008	Architectural Effects on Requirements Decisions- An Exploratory Study
26	WICSA	2008	Coordination Implications of Software Architecture in a Global Software Development Project
27	WICSA	2008	Value-Based Design Decision Rationale Documentation- Principles and Empirical Feasibility Study
28	WICSA	2007	The Impact of Requirements Knowledge and Experience on Software Architecting- An Empirical Study
29	WICSA	2005	A Survey of the Use and Documentation of Architecture Design Rationale
30	WICSA	2002	Practical Rationale for Describing Software Architecture
31	WICSA	2001	An Architecture for Distributing the Computation of Software Clustering Algorithms
32	WICSA	1999	Evolution and Composition of Reusable Assets in Product-Line Architectures- A Case Study
33	WICSA	1999	Structural Analysis of the Software Architecture - A Maintenance Assessment Case Study
34	CBSE	2015	MatchBox- A Framework for Dynamic Configuration of Service Matching Processes
35	CBSE	2015	Measuring the Superfluous Functionality in Software Components
36	CBSE	2014	Enabling collaborative testing across shared software components
37	CBSE	2014	Memory monitoring in a multi-tenant OSGi execution environment
38	CBSE	2013	Parameterised architectural patterns for providing cloud service fault tolerance with accurate costings
39	CBSE	2013	Towards mining informal online data to guide component-reuse decisions

40	CBSE	2012	15 years of CBSE symposium- impact on the research community
41	CBSE	2011	Component deployment optimisation with bayesian learning
42	CBSE	2011	MPM- a modular package manager
43	CBSE	2008	An Empirical Investigation of the Effort of Creating Reusable, Component-Based Models for Performance Prediction
44	CBSE	2007	Performance-Driven Interface Contract Enforcement for Scientific Components
45	CBSE	2006	From Specification to Experimentation- A Software Component Search Engine Architecture
46	CBSE	2006	Multi Criteria Selection of Components Using the Analytic Hierarchy Process
47	CBSE	2005	An Empirical Study on the Specification and Selection of Components Using Fuzzy Logic
48	CBSE	2005	Finding a Needle in the Haystack- A Technique for Ranking Matches Between Components
49	CBSE	2005	Optimizing Resource Usage in Component-Based Real-Time Systems
50	CBSE	2005	Qinna, a Component-Based QoS Architecture
51	CBSE	2005	Unlocking the Grid
52	QoSA	2015	Architecture-based Assessment and Planning of Change Requests
53	QoSA	2015	Investigating Quality Trade-offs in Open Source Critical Embedded Systems
54	QoSA	2015	Making Real Time Data Analytics Available as a Service
55	QoSA	2015	On Architectural Qualities and Tactics for Mobile Sensing
56	QoSA	2015	Scalability, Elasticity, and Efficiency in Cloud Computing - a Systematic Literature Review of Definitions and Metrics
57	QoSA	2014	An empirical investigation of modularity metrics for indicating architectural technical debt
58	QoSA	2014	Architecture management and evaluation in mature products- experiences from a lightweight approach
59	QoSA	2014	Automatic detection of performance anti-patterns in inter-component communications
60	QoSA	2014	Empirical resilience evaluation of an architecture-based self-adaptive software system
61	QoSA	2014	Experiences with modeling memory contention for multi-core industrial real-time systems
62	QoSA	2013	A causal model to predict the effect of business process evolution on quality of service
63	QoSA	2013	A systematic review of system-of-systems architecture research
64	QoSA	2013	Cloud API issues- an empirical study and impact
65	QoSA	2013	Generating service models by trace subsequence substitution
66	QoSA	2013	Leveraging design rules to improve software architecture recovery
67	QoSA	2012	Characterizing real-time reflexion-based architecture recovery- an in-vivo multi-case study
68	QoSA	2012	NASA's advanced multimission operations system- a case study in software architecture evolution
69	QoSA	2011	Architecture-based reliability evaluation under uncertainty
70	QoSA	2011	Sustainability evaluation of software architectures- a systematic review
71	QoSA	2010	Is BPMN Really First Choice in Joint Architecture Development? An Empirical Study on the Usability of BPMN and UML Activity Diagrams for Business Users
72	QoSA	2010	QoS Driven Dynamic Binding in-the-many
73	QoSA	2009	Improved Feedback for Architectural Performance Prediction Using Software Cartography Visualizations
74	QoSA	2009	Successful Architectural Knowledge Sharing- Beware of Emotions
75	QoSA	2008	Design Reasoning Improves Software Design Quality
76	QoSA	2007	Architecture Recovery and Evaluation Aiming at Program Understanding and Reuse
77	QoSA	2007	Factors Influencing Industrial Practices of Software Architecture Evaluation- An Empirical Investigation
78	QoSA	2007	The Architect’s Mindset
79	QoSA	2005	Architectural Reuse in Software Systems In-house Integration and Merge – Experiences from Industry
80	QoSA	2005	Empirical Evaluation of Model-Based Performance Prediction Methods in Software Development
81	ECSA	2015	Architectural Reasoning Support for Product-lines of Self-adaptive Software Systems - A Case Study
82	ECSA	2015	Architecture and Organizational Challenges of Opening Interfaces within a Product Portfolio
83	ECSA	2015	Collecting Requirements and Ideas for Architectural Group Decision-Making Based on Four Approaches
84	ECSA	2015	Improving the Quality of Architecture Design through Peer-reviews and Recombination

85	ECSA	2015	Model-Based Energy Efficiency Analysis of Software Architectures
86	ECSA	2015	Software Designers Satisfice
87	ECSA	2015	The Layered Architecture Recovery as a Quadratic Assignment Problem
88	ECSA	2014	A Fresh Look at Codification Approaches for SAKM: A Systematic Literature Review
89	ECSA	2014	Architecture Strategies for Cyber-Foraging- Preliminary Results from a Systematic Literature Review
90	ECSA	2014	How Do Software Architects Specify and Validate Quality Requirements?
91	ECSA	2014	Interoperability-Related Architectural Problems and Solutions in Information Systems: A Scoping Study
92	ECSA	2014	Scalable Architectures for Platform-as-a-Service Clouds- Performance and Cost Analysis
93	ECSA	2014	Specification and Detection of SOA Antipatterns in Web Services
94	ECSA	2014	Suitability of Software Architecture Decision Making Methods for Group Decisions
95	ECSA	2013	Architectural Decision-Making in Enterprises - Preliminary Findings from an Exploratory Study in Norwegian Electricity Industry
96	ECSA	2013	Claims and Evidence for Architecture-Based Self-adaptation- A Systematic Literature Review
97	ECSA	2013	Classification of Design Decisions: An Expert Survey in Practice
98	ECSA	2013	Controlled Experiment on the Supportive Effect of Architectural Component Diagrams for Design Understanding of Novice Architects
99	ECSA	2013	Software Architecture Documentation for Developers- A Survey
100	ECSA	2012	A Case Study on the Evolution of a Component-based Product Line
101	ECSA	2012	A Study of Architectural Information Foraging in Software Architecture Documents
102	ECSA	2012	Architectural Decision Making for Service-Based Platform Integration - A Qualitative Multi-Method Study
103	ECSA	2012	Forces on Architecture Decisions - A Viewpoint
104	ECSA	2012	Ontology-based Software Architecture Documentation
105	ECSA	2012	Reusable Formal Models for Secure Software Architectures
106	ECSA	2011	Design and Evaluation of a Process for Identifying Architecture Patterns in Open Source Software
107	ECSA	2010	Customer Value in Architecture Decision Making
108	ECSA	2010	Naive Architecting - Understanding the Reasoning Process of Students- A Descriptive Survey
109	ECSA	2009	A case study of the Architecture Business Cycle for an in-vehicle software architecture
110	ECSA	2009	An exploratory study of architectural practices and challenges in using agile software development approaches
111	ECSA	2009	Defining execution viewpoints for a large and complex software-intensive system
112	ECSA	2009	Evolutionary architecting of embedded automotive product lines- An industrial case study
113	ECSA	2009	The lonesome architect
114	ECSA	2008	Evaluating Domain Design Approaches Using Systematic Review
115	ECSA	2008	Stakeholder Perception of Enterprise Architecture

Authors

ID	Academic authors	Industry authors
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110	27
111	14
112	24
113	16
114	16
115	53

Objective formulation

ID	Objective formulation
1	RQs
2	Goals
3	RQs
4	RQs
5	RQs
6	RQs
7	RQs
8	RQs
9	RQs
10	Goals
11	RQs
12	RQs
13	RQs
14	Hypothesis
15	RQs
16	Hypothesis
17	RQs
18	RQs
19	Goals
20	Goals
21	Goals
22	Goals
23	Goals
24	RQs
25	RQs
26	RQs
27	Hypothesis
28	Hypothesis
29	Goals
30	Goals
31	Goals
32	Goals
33	Goals
34	Goals
35	RQs
36	Goals
37	Goals
38	Goals
39	RQs
40	RQs
41	Goals
42	Goals
43	Hypothesis

44	Goals
45	Hypothesis
46	Goals
47	Goals
48	Goals
49	Goals
50	Goals
51	RQs
52	Hypothesis
53	RQs
54	Goals
55	RQs
56	RQs
57	RQs
58	Goals
59	RQs
60	Goals
61	Goals
62	Goals
63	RQs
64	Goals
65	Goals
66	Goals
67	RQs
68	RQs
69	Goals
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71	Hypothesis
72	Goals
73	RQs
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75	Hypothesis
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82	Goals
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84	RQs
85	RQs
86	RQs
87	RQs
88	RQs
89	RQs
90	RQs

91	RQs
92	Goals
93	Hypothesis
94	RQs
95	RQs
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104	Hypothesis
105	Goals
106	Hypothesis
107	RQs
108	RQs
109	Goals
110	Goals
111	Goals
112	RQs
113	RQs
114	RQs
115	Goals

Study focus

ID	Study focus
1	architectural decision making
2	architectural framework (viewpoints)
3	architetecture technical debt
4	architectural knowledge
5	architectural issues
6	design conflict detection
7	architetecture technical debt
8	group decisions
9	qualities: hardware vs software
10	component interfaces
11	architectural decisions documentation
12	adaptive monitoring
13	ecosystems platform boundaries
14	traceability architectural models
15	architecture emerges from continous refactoring
16	viewpoint for online updates
17	variability in architecture
18	architecting reasoning process
19	prioritization of concerns
20	metric for analysability of system decomposition
21	architecture relevant issues
22	architectural knowledge sharing needs
23	use of atchitectural patterns
24	design structure matrices
25	architecture requirements interplay
26	design structure matrices vs communication structure
27	value-based approach to design decision rationale documentation
28	architecture requirements interplay
29	architecture design rationale
30	rationale for architecture design and de- scription
31	distribution of computation
32	reusable assets in product-line architectures
33	assessment of maintainability throughout evolution
34	dynamic service matching
35	component (superflous) functionality
36	testing
37	memory monitoring
38	architectural patterns for cloud
39	data decision making component reuse
40	meta study CBSE
41	component deployment optimisation
42	package installation optimisation
43	performance prediction models

44	interface contract enforcement
45	component reposity search for reuse
46	component selection based on non-functional properties
47	fuzzy specification to rank components
48	ranking component matches
49	optimizing resource allocation
50	component-based QoS architecture
51	requirements and architectural traits of grid
52	change management
53	critical vs non-critical quality attributes in open source projects
54	real time data analytics
55	tactics for mobile systems
56	qualities (metrics) for cloud computing
57	modularity metrics versus modified components per commit (technical debt)
58	architecture evaluation and management
59	performance problems diagnostics
60	handling resilience using architecture-based self-adaptation
61	multi-core performance analysis with queuing networks and Petri nets
62	system evolution analysis and effects on quality properties
63	system of systems architecture
64	cloud infrastructure APIs
65	generating large service models from interaction trace data
66	recovering software architecture with clustering techniques
67	architecture-code consistency
68	architecture evolution
69	reliability evaluation under uncertainty
70	architecture evaluation for sustainability
71	effective business process modeling
72	dynamic service binding and qualities
73	design decisions and performance analysis
74	architecture knowledge sharing
75	design reasoning and quality of design
76	archiecture recovery and evaluation
77	industrial software architecture evaluation
78	view on and use of architectural knowledge
79	software integration and reuse
80	quantitative performance prediction
81	architectural reasoning for self-adaptive systems
82	software ecosystem
83	group decision-making
84	quality of design and decision making
85	power consumption and energy efficiency
86	architecting reasoning process
87	layered style and architecture evolution
88	architecture knowledge management
89	cyber foraging for mobile computing
90	specification and validation of quality requirements

91	interoperability of information systems
92	perfomance and cost of cloud
93	domain-specific language for SOA anti-patterns
94	group decision-making
95	decision making for enterprise application development and ecosystems
96	architecture-based self-adaptation evidence
97	design decisions in practice
98	usefulness of component diagrams
99	architecture documentation for developers
100	evolution of product lines
101	foraging information in architecture documentation
102	decisions for service-based systems with patterns
103	viewpoint for architecture decisions
104	ontology-based architecture documentation
105	formal modeling of security patterns
106	architectural patterns in open source software
107	customer value for decision making
108	architectural reasoning of novice architects
109	architecture business cycle in practice
110	agile practices and architecure
111	execution viewpoint
112	architecting product lines
113	architect practice and knowledge sharing
114	domain design approaches for produc tlines
115	understanding enterprice architecture stakeholders

Reason (f = focus; e = evaluation)

ID	Reason
1	f
2	e
3	e
4	f
5	e
6	e
7	f
8	f
9	e
10	e
11	e
12	e
13	f
14	f
15	f
16	e
17	f
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108	f
109	e
110	f
111	e
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113	e
114	f
115	e

Method

ID	Method
1	survey
2	case study
3	case study
4	interview study
5	experiment
6	experiment
7	case study
8	interview study
9	interview study
10	experiment
11	case study
12	experiment
13	case study
14	experiment
15	interview study
16	experiment
17	case study
18	survey
19	systematic empirical enquiry
20	experiment
21	case study
22	systematic empirical enquiry
23	systematic empirical enquiry
24	systematic empirical enquiry
25	case study
26	systematic empirical enquiry
27	experiment
28	experiment
29	survey
30	systematic empirical enquiry
31	systematic empirical enquiry
32	case study
33	case study
34	case study
35	experiment
36	experiment
37	experiment
38	experiment
39	experiment
40	SLR
41	experiment
42	experiment
43	experiment

44	experiment
45	experiment
46	experiment
47	case study
48	experiment
49	systematic empirical enquiry
50	experiment
51	case study
52	experiment
53	case study
54	case study
55	case study
56	SLR
57	case study
58	case study
59	case study
60	experiment
61	experiment
62	experiment
63	SLR
64	systematic empirical enquiry
65	experiment
66	systematic empirical enquiry
67	case study
68	case study
69	experiment
70	survey
71	experiment
72	experiment
73	experiment
74	survey
75	experiment
76	experiment
77	systematic empirical enquiry
78	survey
79	case study
80	experiment
81	case study
82	case study
83	systematic empirical enquiry
84	case study
85	systematic empirical enquiry
86	systematic empirical enquiry
87	experiment
88	SLR
89	SLR
90	multi-method study

91	systematic empirical enquiry
92	experiment
93	systematic empirical enquiry
94	systematic empirical enquiry
95	interview study
96	SLR
97	survey
98	experiment
99	survey
100	case study
101	systematic empirical enquiry
102	multi-method study
103	case study
104	multi-method study
105	case study
106	experiment
107	case study
108	survey
109	interview study
110	case study
111	case study
112	case study
113	survey
114	SLR
115	case study

Replication and repetition

ID	Replication	Repetition
1	no	no
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55	no	no
56	no	no
57	no	no
58	no	no
59	no	no
60	no	no
61	no	no
62	no	no
63	no	no
64	no	no
65	no	no
66	no	no
67	no	no
68	no	no
69	no	no
70	no	no
71	no	no
72	no	no
73	no	no
74	no	no
75	no	no
76	no	no
77	no	no
78	no	no
79	no	no
80	no	no
81	no	no
82	no	no
83	no	no
84	no	no
85	no	no
86	no	no
87	no	no
88	no	no
89	no	no
90	no	no

91	no	no
92	no	no
93	no	no
94	no	no
95	no	no
96	no	no
97	no	no
98	no	no
99	no	no
100	no	no
101	no	no
102	no	no
103	no	no
104	no	no
105	no	no
106	no	no
107	no	no
108	no	no
109	no	no
110	no	no
111	no	no
112	no	no
113	no	no
114	no	no
115	no	no

Subjects (h = human; n = non-human)

ID	Subjects	Human subjects
1	h	professionals
2	h	professionals
3	h	professionals
4	h	professionals
5	n	n/a
6	h	students
7	h	professionals
8	h	both
9	h	professionals
10	n	n/a
11	h	professionals
12	n	n/a
13	h	professionals
14	h	both
15	h	professionals
16	h	professionals
17	h	students
18	h	professionals
19	h	professionals
20	n	n/a
21	h	professionals
22	h	professionals
23	n	n/a
24	n	n/a
25	h	students
26	h	professionals
27	h	students
28	h	students
29	h	professionals
30	h	professionals
31	n	n/a
32	b	professionals
33	b	professionals
34	h	students
35	n	n/a
36	n	n/a
37	n	n/a
38	n	n/a
39	b	professionals
40	n	n/a
41	n	n/a
42	n	n/a
43	h	students

44	n	n/a
45	n	n/a
46	n	n/a
47	n	n/a
48	n	n/a
49	n	n/a
50	n	n/a
51	n	n/a
52	h	students
53	n	n/a
54	n	n/a
55	h	students
56	n	n/a
57	n	n/a
58	n	n/a
59	n	n/a
60	n	n/a
61	n	n/a
62	n	n/a
63	n	n/a
64	n	n/a
65	n	n/a
66	n	n/a
67	h	professionals
68	n	n/a
69	n	n/a
70	n	n/a
71	h	students
72	n	n/a
73	n	n/a
74	h	professionals
75	h	professionals
76	h	professionals
77	h	professionals
78	h	professionals
79	h	professionals
80	h	students
81	h	students
82	b	professionals
83	h	students
84	h	students
85	n	n/a
86	h	both
87	n	n/a
88	n	n/a
89	n	n/a
90	h	professionals

91	n	n/a
92	n	n/a
93	n	n/a
94	n	n/a
95	h	professionals
96	n	n/a
97	h	professionals
98	h	students
99	h	professionals
100	n	n/a
101	h	both
102	b	professionals
103	b	professionals
104	b	professionals
105	h	professionals
106	h	students
107	b	professionals
108	h	professionals
109	h	professionals
110	h	professionals
111	b	professionals
112	n	n/a
113	h	professionals
114	n	n/a
115	h	professionals

Validity

ID	Validity threats	Internal	External	Construct	Reliability	Conclusion	Not differentiated
1	explicit	y	y	y			
2	implicit						y
3	explicit	y	y	y	y		
4	explicit	y	y	y	y		
5	explicit		y				y
6	explicit						y
7	explicit	y	y				y
8	explicit	y	y				
9	explicit	y	y	y		y	
10	explicit	y	y				
11	explicit	y	y	y	y		
12	explicit		y				y
13	implicit						y
14	explicit	y	y	y		y	
15	explicit						y
16	explicit	y	y				
17	explicit	y	y	y	y		
18	explicit	y	y				
19	no						
20	explicit	y	y				
21	explicit						y
22	no						
23	implicit						y
24	no						
25	explicit	y	y	y		y	
26	no						
27	implicit						y
28	explicit	y	y				
29	explicit						y
30	no						
31	no						
32	no						
33	no						
34	explicit						y
35	no						
36	no						
37	no						
38	no						
39	explicit	y	y				
40	implicit						y
41	no						
42	no						
43	explicit	y	y	y			

44	no						
45	implicit						y
46	no						
47	no						
48	no						
49	no						
50	no						
51	no						
52	explicit	y	y				
53	explicit	y	y	y	y		
54	no						
55	implicit						y
56	explicit	y	y	y		y	
57	explicit	y	y	y		y	
58	explicit	y	y	y	y		
59	explicit		y	y			
60	explicit	y	y				
61	explicit						y
62	explicit						y
63	explicit						y
64	explicit						y
65	no						
66	explicit						y
67	explicit	y	y	y	y		
68	no						
69	explicit	y	y				
70	implicit						y
71	explicit						y
72	no						
73	no						
74	explicit						y
75	explicit						y
76	no						
77	no						
78	explicit						y
79	no						
80	explicit	y	y				
81	explicit	y	y	y			
82	no						
83	no						
84	explicit						y
85	explicit						y
86	explicit		y	y			y
87	explicit	y	y			y	
88	explicit	y	y	y	y		
89	explicit						y
90	explicit	y	y				

91	explicit						y
92	no						
93	explicit	y	y	y			
94	no						
95	explicit	y	y				
96	explicit						y
97	explicit						y
98	explicit	y	y	y		y	
99	explicit						y
100	explicit	y	y	y		y	
101	explicit						y
102	explicit						y
103	explicit	y	y	y	y		
104	explicit	y	y			y	
105	explicit	y	y			y	
106	explicit	y	y	y		y	
107	no						
108	explicit	y	y	y			
109	no						
110	explicit						y
111	no						
112	no						
113	explicit	y	y	y			
114	explicit						y
115	implicit						y